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Andrew J. Majda

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This report covers the period January 1, 1989 through December 31, 1991, the three year period of this grant. The research performed under this grant includes mathematical analysis of strong fluid mechanical effects at high Mach number in reactive flow. The principal investigator has published the following papers with at least partial support by this research grant:

1. (with M. Avellaneda) "Stieltjes integral representation and effective diffusivity bounds for turbulent transport", *Phys. Rev. Lett.*, Vol. 62, No. 7, pp. 753-755, March 1989
2. (with M. Artola) "Nonlinear kink modes for supersonic vortex sheets", *Phys. Fluids*, pp. 583-596, March 1989
3. (with Y.S. Choi) "Amplification of small-amplitude high-frequency waves in a reactive mixture", *SIAM Review*, Vol. 31, pp. 401-427, September 1989
4. (with M. Artola) "Nonlinear development of instabilities in supersonic vortex sheets II: resonant interaction among kink modes", *SIAM J. Appl. Math.*, Vol. 49, pp. 1310-1349, October 1989
5. (with R. Almgren & R. Rosales) "Rapid initiation in condensed phases through resonant nonlinear acoustics", *Phys. Fluids A*, 2(6), pp. 1014-1029, June 1990
6. (with V. Roytburd) "Numerical study of the mechanisms for initiation of reacting shock waves", *SIAM J. Sci. Stat. Comput.*, Vol. 11, No. 5, pp. 950-974, September 1990
7. (with M. Avellaneda) "Mathematical models with exact renormalization for turbulent transport", *Commun. Math. Phys.*, 131, pp. 381-429, 1990
8. One Perspective on Open Problems in Multi-Dimensional Conservation Laws. Published, *IMA, Vol. 29 on Multidimensional Hyperbolic Problems and Computations*, Edited by J. Glimm and A. Majda, pp. 217-238, 1990

9. (with M. Avellaneda) Homogenization and Renormalization of Multiple-Scattering Expansions for Green Functions in Turbulent Transport. Published in *Composite Media and Homogenization Theory*, Birkhauser, Boston, Edited by Dal Mao and Dell'Antonio, pp. 13-37, 1990
10. (with A. Bourlioux and V. Roytburd), "Theoretical and numerical structure for unstable one-dimensional detonations", *SIAM J. Appl. Math.*, Vol. 51, No. 2, pp. 303-343, April 1991
11. (with M. Avellaneda) "An integral representation and bounds on the effective diffusivity in passive advection by Laminar and turbulent flows", *Commun. Math. Phys.* 138, pp. 339-391, 1991
12. (with R. Almgren and R. Rosales) "Asymptotic analysis of reacting materials with saturated explosion. I. Low-frequency waves", *Studies in Applied Mathematics* 84, pp. 275-313, 1991
13. (with R. Almgren and R. Rosales) "Asymptotic analysis of reacting materials with saturated explosion. II. High-frequency waves", *Studies in Applied Mathematics* 84, pp. 315-360, 1991
14. (with R. Klein) "Self-stretching of a perturbed vortex filament I. The asymptotic equation for deviations from a straight line", *Physica D* 49, pp. 323-352, 1991
15. (with A. Bourlioux and V. Roytburd) "Nonlinear development of low frequency one-dimensional instabilities for reacting shock waves", *IMA Volumes in Mathematics and its Applications*, Vol. 35, pp. 63-82, 1991
16. (with K. Lamb) "Simplified equations for low mach number combustion with strong heat release", *IMA Volumes in Mathematics and its Applications*, Vol. 35, pp. 167-211, 1991
17. (with M. Avellaneda), "An integral representation and bounds on the effective diffusivity in passive advection by Laminar and turbulent flows", *Commun. Math. Phys.*, Vol. 138, pp. 339-391, 1991
18. "The interaction of nonlinear analysis and modern applied mathematics", *Proceedings of the International Congress of Mathematicians*, Kyoto, pp. 175-189, 1991
19. "Vorticity, turbulence, and acoustics in fluid flow", *SIAM Review*, Vol. 33, No. 3, pp. 349-388, 1991
20. (with R. Klein), "Self-stretching of perturbed vortex filaments II. Structure of solutions", *Physica D*, vol. 53, pp. 267-294, 1991

21. (with M. Avellaneda), "Approximate and exact renormalization theories for a model for turbulent transport", *Phys. Fluids A*, Vol. 4 (1), pp. 41-57, 1992

Submitted Papers of A. Majda

1. (with M. Avellaneda), "Renormalization theory for eddy-diffusivity in turbulent transport", submitted to *Phys. Rev. Letters*, September 16, 1991
2. (with P. Embid and J. Hunter), "Simplified asymptotic equations for the transition to detonation in reactive granular materials", accepted, *SIAM J. Appl. Math.*
3. (with P. Embid), "An asymptotic theory for hot spot formation and transition to detonation for reactive granular materials", accepted, *Combustion and Flame*
4. (with A. Bourlioux), "High resolution numerical simulations for two dimensional unstable detonations", submitted to *A.I.A.A. Journal*, January 9, 1992
5. (with A. Bourlioux), "Theoretical and numerical structure for unstable two dimensional detonations", submitted to *Combustion and Flame*, November 11, 1991
6. (with M. Avellaneda), "Mathematical models with exact renormalization for turbulent transport, II: fractal interfaces, non-Gaussian statistics and the sweeping effect", accepted, *Comm. Math. Phys.*

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Andrea Bertozzi, graduate student, received Ph.D. 6/91

Anne Bourlioux, graduate student, received Ph.D. 6/91

David Horntrop, graduate student, Ph.D. expected 6/94

Richard McLaughlin, graduate student, Ph.D. expected 6/93

David Stuart, graduate student, received Ph.D. 6/90

Pedro Embid, visiting research scientist, 9/89 through 6/90